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Determining social-psychological drivers of Texas Gulf Coast homeowners' intention to implement private green infrastructure practices

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ABSTRACT

Green infrastructure (GI) has been demonstrated to be an efficient flood mitigation measure and an effective approach for building community resilience, especially in the context of climate change. Drawing on Protection Motivation Theory, this study offers insight into the factors influencing residents' intention to implement individual GI practices by homeowners along the Texas Gulf Coast. The GI practices examined included the potential installation of (1) green roofs, (2) rain barrels, (3) rain gardens, (4) permeable pavement, and (5) tree protection and planting. Our findings revealed that homeowners expressed little interest in adopting GI practices owing to the lack of information, absence of incentives, and guidance on how to implement GI practices. Moreover, the findings from our modeling confirmed that perceptions of the effectiveness and cost of GI had the strongest influence on respondents' intention to implement GI. Other significant indicators such as threat appraisal, reliance on public flood protection, perceived co-benefits, age, and the number of children varied with specific GI practices. These findings provide valuable information for city policymakers and planners in coastal regions concerning the promotion and development of GI that can meet the needs of their residents, provide the impetus for implementation, and in turn, contribute to community resilience.

Keywords: green infrastructure, flood mitigation, Texas Gulf Coast, homeowners' perception

1. INTRODUCTION

Flooding stemming from stochastic storm events poses the greatest threat to human lives and economic well-being of coastal communities in the U.S. Along the Texas Gulf Coast, the low-lying coastal areas make it extremely vulnerable to the adverse effects of flooding caused by heavy rainfall and storm surge (Brody et al., 2013). Over the past five years, a multitude of storm events have severely impacted cities along the Texas Gulf Coast, such as Hurricane Harvey (2017), Tropical Storm Imelda (2019), Hurricane Hanna (2020), Hurricane Laura (2020), Hurricane Nicholas (2021) and numerous others. However, living close to the water is still considered an amenity that has attracted millions of people and essential industries to the Texas Gulf Coast. The development of land for residential, commercial, agricultural, industrial, and institutional uses as well as the improvement of infrastructure systems has led to the loss, degradation, and fragmentation of coastal ecosystems (Kim & Tran, 2018; Williamson, 2003). At the same time, this development has resulted in the loss of an array of ecosystem services, increasing the cost burden of public services, and has increased the risk of exposure to natural hazards faced by residents of coastal communities. Traditional structural mitigation and protection measures such as flood barriers, levees, and reservoirs, often require extensive investment in buildings and infrastructure and sometimes result in unintended consequences caused by interruption to natural processes, inadequate protection, and even failure during disaster events (Schwab, 2014).

A potentially complementary approach is the development of green infrastructure (GI) which has been demonstrated an efficient flood mitigation measure and effective approach for building community resilience (McPhearson et al., 2015). Despite governmental efforts in promoting GI, local residents sometimes lack the motivation to implement individual GI practices on their properties or contribute to the development of GI within their communities. Even when GI is provided at no cost or with incentives, resident participation rates in GI projects have been low (Baptiste et al., 2015; Mayer et al., 2012; Turner et al., 2016). The lack of acceptance and adoption of GI may prevent coastal residents from taking full advantage of the array of services afforded by GI and miss opportunities to build resilience and protect themselves and their households from future extreme flood events. With this in mind, the paper explored several drivers of Texas Gulf Coast homeowners' willingness to adopt specific GI practices.

1.1. Study background

Green infrastructure is defined as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Benedict & McMahon, 2002, p. 12). The term is often used interchangeably with low-impact development (LID), green stormwater infrastructure, blue-green infrastructure, sustainable urban drainage systems (SUDs), and even green spaces.

GI can be implemented at any scale varying from an individual parcel (site), local community, city, state, and even multi-state region (Benedict & McMahon, 2012). At the site scale (e.g., households), GI mimics natural systems by absorbing stormwater into the ground, using trees for evapotranspiration, and using rain barrels to capture and store stormwater for household uses. At the community scale, GI incorporates planning and design approaches (e.g., mixed-use development, efficient use of parking, and green spaces) to reduce impervious surfaces and create attractive and livable communities. At the regional scale, GI is the interconnected network of large-scale green spaces (e.g., preserved and restored wetlands) that provides a range of ecosystem services (USEPA, 2009). In urban areas, GI installations can fit well in urban environments, such as green roofs, rain gardens, porous pavers, rain barrels, and many other practices that capture and store stormwater close to where it falls.

Successful GI planning requires coordination and participation between different stakeholder groups (Le & Tran, 2023). In addition to the government and organizational collaborations, a focus on private property stormwater management is needed. Moreover, many strategic locations for GI will be on privately owned land, so private sector involvement will be necessary to implement an effective, comprehensive GI plan (Kramer, 2014). By installing individual GI practices, private homeowners have an opportunity to both protect their homes and properties while contributing to overall flood mitigation and stormwater management for the community/city where they live (Beery, 2018).

Despite governmental efforts in promoting GI across scales, public knowledge of GI has remained low (Venkataramanan et al., 2020). In addition, residents sometimes lack the motivation to adopt GI or participate in the implementation of GI. Many communities are unaware of the benefits of GI or believe it is more costly, less efficient, and difficult to implement compared to engineered approaches (Foster et al., 2011). Others choose not to adopt it because they do not perceive GI to be a viable mitigation measure or assume it has already been adopted by the government (Keeley et al., 2013). The lack of acceptance can also stem from the lack of information, incentives, or institutional support (Stern, 1999), but it may be also influenced by other underlying factors, such as socio-demographic (e.g., age, gender, income, and owner/renter) and perceptual factors (e.g., flood risk perception, experience, self-efficacy, and reliance of public flood protection) (Baptiste et al., 2015; Byrne et al., 2015; Madureira et al., 2015; Turner et al., 2016; Williams et al., 2019; Yu et al., 2019). Currently, little is known about how perceptual factors shape GI adoption.

1.2. Theoretical approach

Using Protection Motivation Theory (Rogers, 1975) we explored the influence of both socio-demographic factors (e.g., age, income, education levels) and perceptual factors (e.g., risk perception, previous experience, response effectiveness, and cost) on respondents' intent to adopt several GI practices. The theory has been used in many studies across the world to understand individual flood preparedness and protective decisions; including Germany (P Bubeck, WJW Botzen, et al., 2012; Grothmann & Reusswig, 2006), Vietnam (Reynaud et al., 2013), France (Poussin et al., 2015), and Australia (Franklin et al., 2014).

PMT infers that self-protective behavior is a product of two psychological processes: *threat appraisal* and *coping appraisal* (Birkholz et al., 2014). In the context of this investigation, *threat appraisal* (also known as risk perception) refers to an individual's concern about pending flood events in terms of *perceived probability* and *perceived severity* of the consequences stemming from the threat. *Perceived probability* is an individual's expectation of being exposed to a flood. Alternately, *perceived severity* is the individual's assessment of the harm stemming from future flood events (Grothmann & Patt, 2005).

The second process, *coping appraisal,* refers to an individual's assessment of their ability to cope and protect themselves from harm associated with the threat, together with the cost of coping (Grothmann & Reusswig, 2006). In the context of GI in this study, *coping appraisal* refers to the evaluation of resources required to install GI such as planting trees, using permeable pavement, rain gardens, and constructing green roofs on private properties. Coping also includes *perceived response efficacy/effectiveness* (e.g., the extent to which one believes that the adoption of GI practices can mitigate the negative consequences of flood events), and *perceived cost* (e.g., perceived individual costs connected to the use of a specific GI practice, including perceived time, effort, and money spent). Along with variables drawn from prior PMT research, we included an additional variable in coping appraisal that captures homeowners' recognition of many other benefits of GI (in addition to flood protection). It has been found to increase the adoption of GI by both local governments and their residents (Byrne et al., 2015; Foster et al., 2011).

Drawing from Grothmann and Reusswig (2006) we also included *threat experience appraisal* and *reliance on public flood protection* as the expansion of PMT. *Threat experience appraisal* is the individual's experience with previous flood events. Alternately, */reliance on public flood protection* refers to a person's *satisfaction with public flood protection measures*, and their *trust in the governmental management of flood risks.* These elements are more likely to compel individuals at risk to rely on non-individual flood protection and ignore personal protective actions.

Socio-demographic variables such as age, income, education, and number of children were also integrated into our hypothesized model (see Figure 1). This model examined homeowners' evaluation and attitude towards each GI practice in terms of perceived benefits, cost, and effectiveness. Details of the five GI practices can be found in Appendix A.

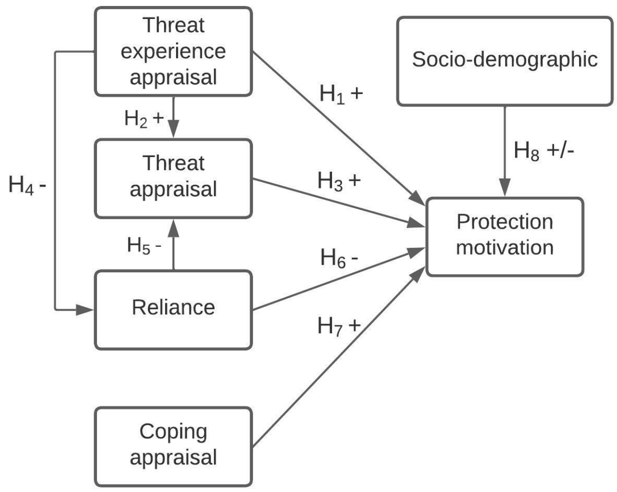

Figure 1. Hypothesized path model applied for the five green infrastructure practices

1.3. Hypotheses

1.3.1. Effects of threat experience appraisal and threat appraisal/ risk perception

As noted, past experience or threat experience appraisal is the individual's experience with prior flood events. Past experience with flooding has been recognized as a potential driver motivating people to take flood protective action (Coleman et al., 2018; Kreibich et al., 2011; Lindell & Hwang, 2008; Yu et al., 2019). This work is the basis for our first Hypothesis 1 (H1).

> *H1*: Past experience (threat experience appraisal): We hypothesize that homeowners who have previously experienced flood events will be more willing to implement GI practices to protect their households from future flooding (protection motivation).

One of the most cited variables related to the perception of natural hazards is past experience (Peacock et al., 2005). One would expect that personal experience with a natural hazard event would lead to a heightened perception of risk. Peacock et al. (2005) suggested that individuals who had previously experienced hurricane damage were more likely to express concern over the risk posed by future events compared to those without prior experience. Furthermore, Burger and Palmer (1992) noted that people who had prior experience with natural disasters like earthquakes expressed greater concern over the potential of future events. However, the existing literature on risk perception also shows an undermining psychological effect of risk perception; namely, risk perception normalization. When people are continuously aware and experience a threat, they tend to cope and develop strategies to minimize the perceived risk, which leads to a negative association between the presence and awareness of a hazard and an individual's risk perception (Luís et al., 2018). It is worth mentioning that the literature exploring the connection between experience and risk perception has yielded varying outcomes. While certain studies have indicated a negative correlation, others have failed to establish any significant relationship. However, a majority of studies have consistently demonstrated a positive correlation. As a result, our study put forward the second hypothesis (H2) below.

> *H2*: Past experience (threat experience appraisal): Homeowners who have experienced flood events previously will be more inclined to indicate high probabilities of future events (H2a) and severity of flood risk (H2b).

Despite some promising evidence, the effects of flood risk perception on motivation to adopt GI remains uncertain. For many years, the perception of risk has long been recognized as a key element of flood risk management (Buchecker et al., 2013). The perception of risk girds residents' understanding of the threat posed by natural hazards and their responses to these threats (Bardsley & Edwards-Jones, 2007; Bötzen & van den Bergh, 2012; Terpstra, 2011). Some previous work has reported weak associations (P Bubeck, W Botzen, et al., 2012). Other studies provide evidence that although people have high-risk perceptions, they do not always adopt preparedness and protective actions (Derkzen et al., 2017; Hall & Slothower, 2009; Jóhannesdóttir & Gísladóttir, 2010; Karanci et al., 2005). Therefore, we proposed the following two hypotheses.

> *H3*: Risk perception (threat appraisal): Homeowners who anticipate a greater probability (H3a) and severity of flood events (H3b) will be more motivated to implement GI practices.

> *H4*: Past experience (threat experience appraisal): Homeowners who have previously experienced flood events will have less satisfaction in current public flood protection measures (H4a) and trust in public management of flood risk (H4b).

1.3.2. Effects of reliance on public flood protection

Reliance on public flood protection reflects the public's level of trust in the government's public protection measures and management of flood risk. Literature suggests that trust is important for understanding risk reduction behavior. Individuals are less prone to prepare or adopt protection measures if he/she has little confidence in the effectiveness of public flood protection measures and policy (Babcicky & Seebauer, 2017; Becker et al., 2014; Grothmann & Reusswig, 2006). Nevertheless, certain studies have indicated that public flood protection measures can potentially encourage flood-prone households to adopt protective actions (Poussin et al., 2014; Reynaud et al., 2013; Richert et al., 2017). Thus, the effect of reliance on motivation to take protective action remains unclear and needs further investigation. In this study, we proposed the following hypotheses.

> *H5*: Reliance on public flood protection: Reliance will negatively affect threat appraisals in terms of threat probability (H5a,c) and threat severity (H5b,d).

> *H6*: Reliance on public flood protection: Reliance will negatively influence the implementation of private GI practices.

1.3.3. Effects of coping appraisal

Coping appraisal, the evaluation of resources to conduct GI practices, has been reported to have a strong influence on private flood mitigation behavior; even stronger than threat appraisal (P Bubeck, W Botzen, et al., 2012). Past work has reported several key variables related to coping appraisal that influence individual's motivation and response toward GI including effectiveness, cost, and the co-benefits of GI. For example, in Baptiste et al. (2015) research in Syracuse, NY, they reported that GI efficacy and cost were among the key factors affecting Syracuse residents' willingness to adopt GI. Also, due to the deficiency of information demonstrating GI benefits, costs, and performance, residents are often unsure about the cost to install GI, especially the non-monetary costs (Turner et al., 2016). Barnhill and Smardon (2012) also reported that monetary barriers (e.g., up-front individual costs) influenced Syracuse residents' decision to install GI in/around their homes and their neighborhoods. They concluded that residents are more receptive if GI is offered at low cost or free (Baptiste et al., 2015; Barnhill & Smardon, 2012).

While the US has placed greater emphasis on GI's effectiveness for managing stormwater, its connections to grey infrastructure, and the protection of natural systems, recognition of many other benefits of GI has also shaped the adoption of GI by both local governments and their residents (Foster et al., 2011). For example, Beloqui (2020) reported that a crucial factor increasing the implementation of GI is communicating the provision of multiple GI benefits in addition to flood protection. Byrne et al. (2015) also reported that the acceptance of GI is likely to be influenced by the public understanding of the multiple benefits of GI. The findings from previous research described above provide the rationale for the seventh hypothesis (H7).

> *H7*: Coping appraisal: Respondents who perceive higher effectiveness (H7a), lower cost (H7b), and more co-benefits (H7c) of private GI practices will express a stronger intent to implement those practices.

1.3.4. Effects of socio-demographic characteristics

Numerous studies have examined the relationship between different socio-demographic variables and the intention to adopt GI practices. However, the effects of these variables have been inconsistent. For example, Byrne and Wolch (2009) reported a significant association between age and the use of GI in the form of urban trees. Older residents were more appreciative of the benefits of urban trees for managing climate change impacts. In contrast, Baptiste (2014) reported that adolescents were more likely to express a willingness to adopt GI measures such as rain barrels, rain gardens, trees, porous pavements, and curbside extensions compared to older adults. Similarly, in Shandas et al. (2010) study in Portland (OR), they reported that the younger respondents were more likely to implement and maintain GI. Also, household income and level of education have often been reported to significantly and positively influence intentions to implement GI (Cote & Wolfe, 2014; Derkzen et al., 2017; Reynaud et al., 2017). Given the mixed findings reported in the literature, we can offer no directional hypotheses, a priori. While we anticipate significant associations, the literature provides little guidance on the valence of these associations.

2. METHODS AND DATA ANALYSIS

2.1. Setting

Homeowners residing in 27 Texas cities across the Gulf Coast (e.g., Baytown, Corpus Christi, Galveston, Harlingen, League City, Pearland, etc.) were targeted for participation in the study. These cities are located across 8 flood planning regions as defined by the Texas Water Development Board. A combination of extreme rainfall and storm surges will pose much greater flood risk to these coastal cities. In particular, towards the end of the century, extreme rainfall-surge events may occur approximately once every five years, amplifying the potential for devastating flooding (Gori et al., 2022). Moreover, based on flood factor data provided by the First Street Foundation, these cities have a moderate to extreme risk of flooding over the next 30 years. So, it is expected that respondents in this study would, to some degree, be prepared for flooding and have some knowledge of different flood damage mitigation measures. A questionnaire was administered online in the summer of 2021 via Qualtrics. Survey respondents were recruited from a Cint^{TM} survey panel and were then sent an email describing the study's purpose and a web link to the questionnaire in addition to the institution-approved informed consent protocol. As a result, 608 completed responses were received (Figure 2).

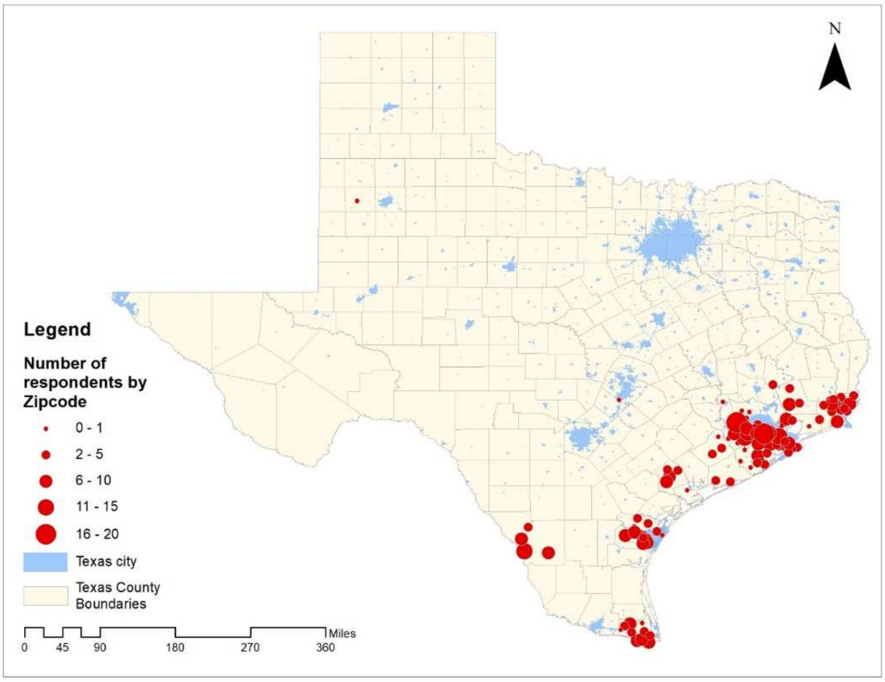

Figure 2. Number of completed surveys by zip-code

2.2. Measures

The questionnaire was developed from similar studies framed around PMT. Most of the PMT constructs were measured on Likert-type multi-item scales. *Threat experience appraisal* or previous flood experience was captured by respondents' reports of whether or not they had previously experienced a flood event in their city.

For *threat appraisal* (also known as *risk perception*), respondents were asked to assess the probability and severity of the flood events affecting their homes within the next ten years (Philip Bubeck et al., 2012; Grothmann & Reusswig, 2006). Response categories were measured on a 5-point scale ranging from 1 ("extremely likely") to 5 ("extremely unlikely") and answers for severity were measured on a 10-point scale ranging from 0 ("not at all") to 10 ("catastrophically")

Coping appraisal refers to the evaluation of resources to conduct GI practices, including perceived *response effectiveness,* perceived *response cost*, and perceived *co-benefits*. *Response efficacy* was measured by asking respondents to rate the perceived effectiveness of the GI practices on a five-point scale ranging from 1 ("very effective") to 5 ("very ineffective"), and (2) *response cost* ranging from 1 ("very high") to 5 ("very low") (Babcicky & Seebauer, 2019). There was also the option of "Don't know" if respondents were unsure about the effectiveness of each GI practice. To measure *perceived co-benefits,* respondents were asked to report the benefits of GI practices in three categories: social (6 items), environmental (5 items), and economic (4 items) (Alves et al., 2018; Derkzen et al., 2017) (Table 1). The variable represents the sum of all perceived co-benefits associated with a specific GI practice. Response effectiveness, response cost, and perceived co-benefits were all evaluated for each of the five GI practices separately.

Table 1. Selected co-benefits of GI practices

Categories	**Co-benefits**
Social	1. Aesthetic/ visual attraction 2. Recreation and health 3. Contact with nature 4. Socializing 5. Education 6. Food security
Environmental	7. Water quality improvement 8. Air quality improvement 9. Groundwater recharge 10. Cooling 11. Promotion of biodiversity
Economic	12. Rainwater harvesting 13. Pumping, treatment reduction 14. Saving energy 15. Real estate value

Reliance on non-individual flood protection was measured by asking respondents about their satisfaction with the current public flood protection measures (Reliance 1) and their trust in the public management of flood risks (Reliance 2) (Babcicky & Seebauer, 2019; Seebauer & Babcicky, 2018). Responses were measured on a 5-point scale ranging from 1 ("strongly agree") to 5 ("strongly disagree").

For respondents' s*ocio-demographic characteristics*, *age* was coded into four age groups. *Income* was comprised of nine categories from less than $25,000 to $300,000 and more. *Education* was coded into five broad categories. And the *children* variable was measured as the number of children under the age of 18 living in the household (Appendix D).

Finally, *protective motivation* or *intention* refers to respondents' intention to adopt any of the five GI practices. Respondents were asked about the likelihood of them installing green roofs, rain barrels, rain gardens, permeable pavement, tree protection, and planting on their properties to protect their households from future flooding. Responses were measured on a 5-point scale, ranging from 1 ("very unlikely") to 4 ("very likely") and 5 ("already done"). *Protective motivation,* however, is distinguished from *protection response*, which is the actual behavior and action that has been taken to prevent damage. Item wording used in the survey instrument is displayed in Appendix D.

2.3. Data analysis

Data were cleaned and analyzed using SPSS 28. Responses to "Don't know" found in the items of perceived effectiveness and cost for each GI practice were treated as missing values and were deleted from the sample. The final sample sizes for the five GI practices ranged from 323 (green roofs) to 408 (rain barrels).

Models were estimated using LISREL 11 (see Figure 1). Model fit was assessed using the Comparative Fit Index (CFI) (Bentler, 1990), the Tucker & Lewis index (NNFI) (Tucker & Lewis, 1973), the root-mean-square error of approximation (RMSEA) (Brown & Cudeck, 1993; Steiger & Lind, 1980), and the root-mean-square-residual (RMSR). Criteria for assessing the adequacy of these indices were; CFI > 0.90, NNFI >0.90 (Bentler & Bonett, 1980), RMSEA < 0.06, and RSMR<0.08 (Hu & Bentler, 1999).

In addition, clustering effects of geographical regions, including city and flood planning region were considered by utilizing 2-level path analyses. Intracluster correlation coefficients (ICCs) were then calculated for each of the 5 GI models to identify the level of similarity of responses within a cluster. Based on Killip et al. (2004), ICC value of 1 indicates that all responses within a cluster are the same while a very small ICC value (closer to 0) suggests no correlation of responses within a cluster.

3. RESULTS

3.1. Socio-demographic profile

Demographically, the majority of the respondents were women (67.93%). The distribution of respondents' age was 31.74% between 18 and 25, 34.05% between 26 and 45, 23.03% between 46 and 65, and 11.18% 66 years or older (Appendix B). The mean number of years residing in their cities was 12.27. For education, only 21.55% of respondents reported having a bachelor's degree and 11.84% reported a master's, doctoral or professional degree. About twenty-three percent of the households reported annual income of less than $25,000, 74% between $25,000 and $299,999, and 3% reported $300,000 and more. Regarding race, about 50% of the respondents were White, 12% Black, 23% Hispanic, 7% Asian, and the rest were from other races. Based on data from the 2022 Regional Report of Texas Comptroller of Public Accounts, the sample used in this study shared similarities with the populations of Texas Gulf Coast cities in terms of education level and income. However, it was observed that the sample was notably whiter and older than the population. This difference can be attributed to the study's focus on homeowners, which may have influenced the demographic composition of the sample.

3.2. Descriptive statistics

Among all the respondents, 60.53% declared they had previously experienced a flood event. Although many cities in the Texas Gulf Coast are at severe to extreme risk of flooding, respondents' perceived probability (M=2.961, SD=1.14) and severity of upcoming flood events (M=4.166, SD=2.59) were less than moderate. In terms of reliance, respondents also reported moderate satisfaction with current public flood protection measures (M=2.987, SD=1.13) and trust in public management of flood risk (M=2.457, SD=1.13) (Appendix C).

With regarding to respondents' current adoption of GI practices, rain barrels and tree planting and protection were most frequently reported as "already adopted." Other practices (including green roofs, rain gardens, and permeable pavements) were less likely to have been adopted with adoption rates of 34.6%, 30.3%, and 32.8%, respectively. Only 13.5% of respondents reported that they had not heard of GI or any of these GI practices. In terms of GI effectiveness, the mean score for each GI practice ranged from 3.06 to 3.67, suggesting that respondents considered GI somewhat effective for mitigating the negative impacts of floods.

In terms of GI cost, while the costs of green roofs and permeable pavements were perceived as high, rain barrels and rain gardens were considered low-cost measures. Despite the differences in the perceived cost and effectiveness of GI practices, the likelihood that respondents would implement such GI practices was, at best, moderate (Figure 3). Green roofs and permeable pavements were reported to be significantly lower in terms of respondents' intention to implement whereas rain barrels and tree protection and planting were the most likely to be adopted.

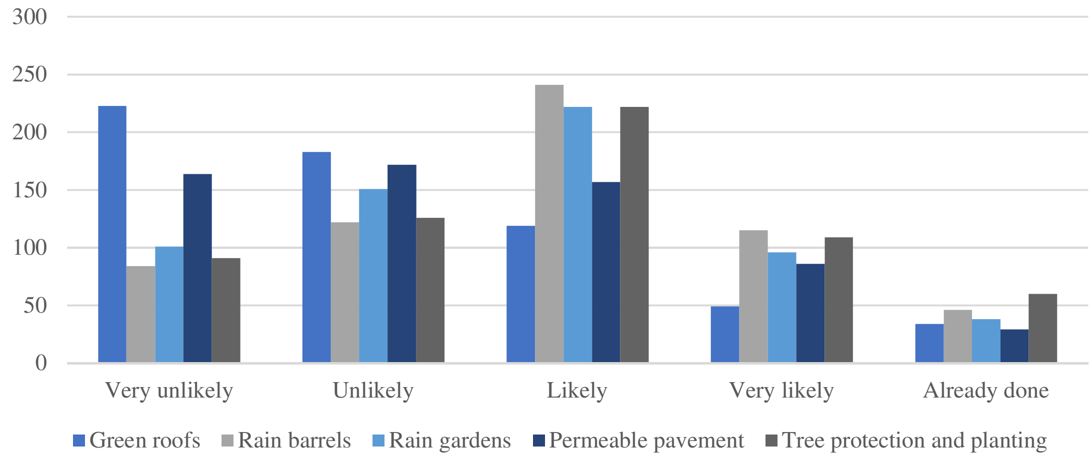

Figure 3. Survey responses reporting homeowners' likelihood to implement each GI practices

The main reason respondents preferred such GI practices is that they found them to be useful and attractive (47.02%). The second reason is that those practices are currently lacking around their homes (33.28%). About 25.66% of respondents also believe those practices can contribute to stormwater management and flood mitigation. Other responses such as affordability and ease of implementation were also reported. In contrast, the main reason contributing to respondents' least preferred GI practice was that they did not have enough information about those measures (47.02%). They also indicated that they did not consider these measures to be effective for mitigating risk from flooding (29.47%); suggesting a lack of incentive and guidance (18.87%) and considered flood protection and stormwater management was the responsibility of the government (12.25%).

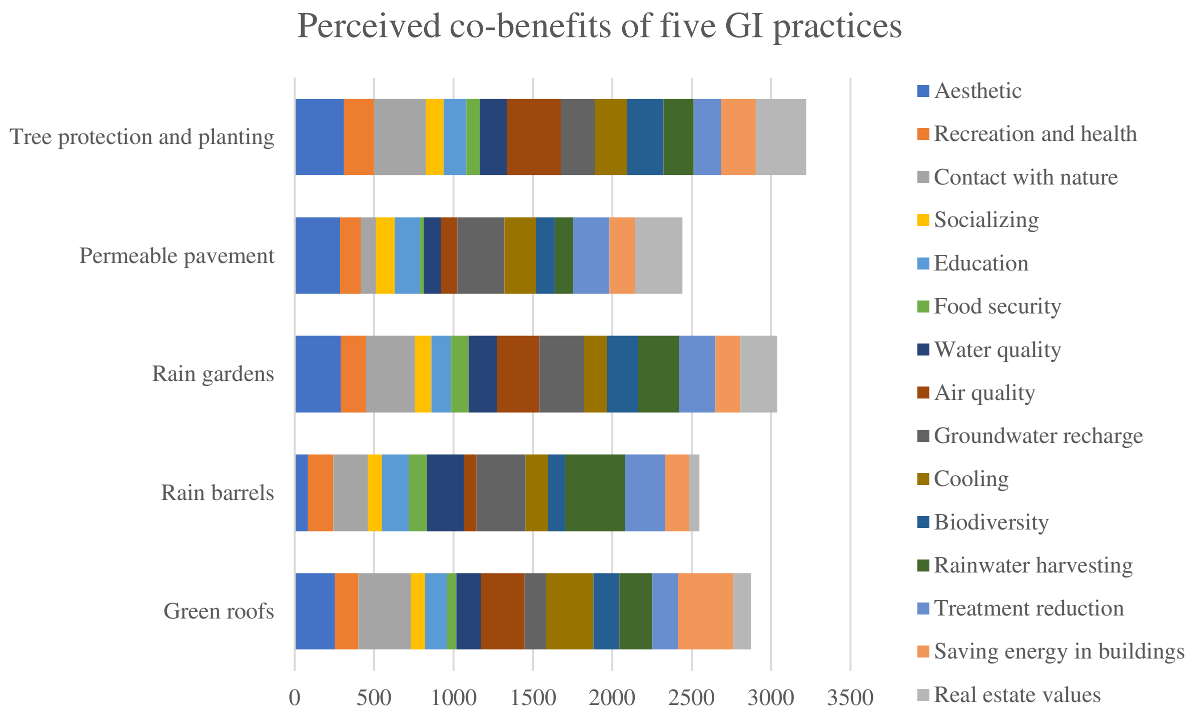

Figure 4. Perceived co-benefits of five GI practices

In terms of co-benefits, tree protection and planting, and rain gardens were considered most beneficial by respondents, while permeable pavements were considered the least. Based on Figure 4, respondents appeared not to fully recognize the capacity of the five GI practices to improve the water quality, which has been known as a critical function of GI across scales (USEPA). Cooling was also less often noted by respondents. Such co-benefits as aesthetic, contact with nature, groundwater recharge, and rainwater harvesting were among the most acknowledged.

3.3. Model testing

For each GI practice, the intention to adopt the practices was regressed onto the social-psychological and socio-demographic variables depicted in Figure 1. Collectively, the fit indices indicate that the models were a satisfactory fit to the data (Table 2). While some of the NNFI and CFI values were slightly below the established thresholds, other fit indices indicated good fit.

Overall models of green roofs, rain barrels, rain gardens, permeable pavements, and tree protection and planting explained 19.5%, 14.7%, 11.1%, 15.8%, and 14.7% of the variance, respectively.

Table 2. Goodness of fit indices for the predictors of intention using PMT model

Model	N	χ^2 (df)	CFI	NNFI	RMSEA	SRMR
Green roof	323	72.771 (59)	.970	.960	.027	.057
Rain barrel	408	121.754*** (58)	.906	.874	.052	.062
Rain garden	373	81.046* (58)	.956	.941	.033	.051
Permeable pavement	379	123.194*** (56)	.890	.846	.056	.065
Tree planting and protection	401	80.332* (57)	.960	.945	.032	.050

**p*<0.05; ***p*<0.01; ****p*<0.001.*

3.4. Summary of effects model

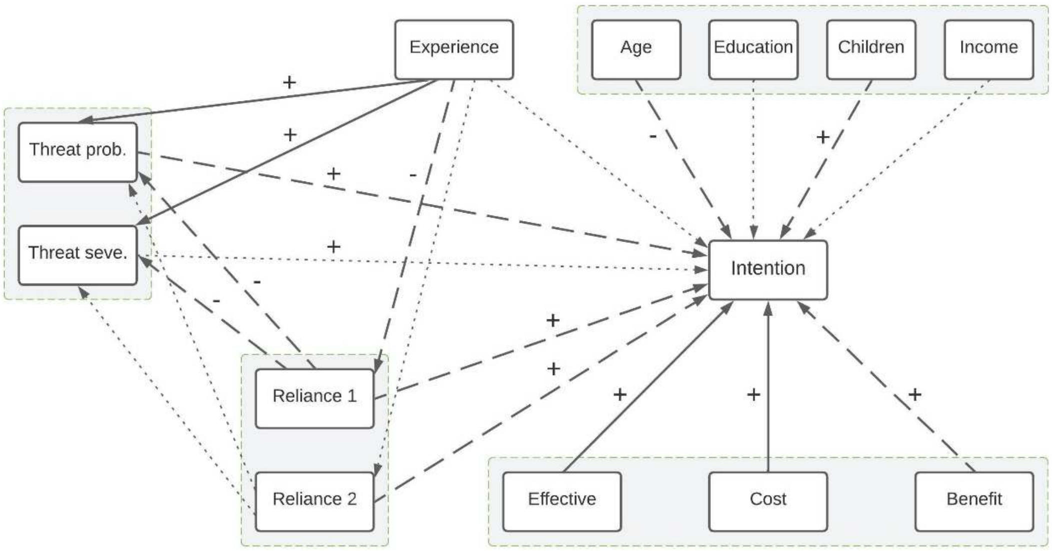

Figure 5. Path analysis results for all five GI models.
Notes. Continuous lines represent statistically significant relationships across models. Dashed lines represent an inconsistent relationship between models and dotted lines represent statistically non-significant relationships across models.

3.4.1. Effects of threat experience appraisal and threat appraisal

Table 3. Summary of results of hypotheses

Hypothesis	**Result (β)**				
	Green roof	**Rain barrel**	**Rain garden**	**Permeable pavement**	**Tree planting and protection**
H1: Experience → Intention	*s.i*	*n.s.*	*s.i.*	*s.i.*	*s.i.*
H2a: Experience → Threat probability	.230***	.216***	.221***	.189***	.195***
H2b: Experience → Threat severity	.218***	.205***	.190***	.184***	.182***
H3a: Threat probability → Intention	.144**	*n.s.*	.112*	.136**	.104*
H3b: Threat severity → Intention	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
H4a: Experience → Reliance 1	-.117*	-.132**	-.129**	*n.s.*	-.097*

H4b: Experience → Reliance 2	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
H5a: Reliance 1 → Threat probability	*n.s.*	-.146**	-.159**	-.125*	-.156**
H5b: Reliance 1 → Threat severity	*n.s.*	-.142**	-.173***	-.123*	-.161***
H5c: Reliance 2 → Threat probability	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
H5d: Reliance 2 → Threat severity	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
H6a: Reliance 1 → Intention	*n.s.*	*n.s.*	*s.i.*	*s.i.*	.094*
H6b: Reliance 2 → Intention	.152**	*n.s.*	.165***	.158***	*n.s.*
H7a: Effectiveness → Intention	.174***	.301***	.228***	.097*	.263***
H7b: Cost → Intention	.235***	.138**	.144**	.222***	.145**
H7c: Co-benefit → Intention	*n.s.*	.151**	*n.s.*	.110*	.164***
H8a: Age → Intention	-.246***	*n.s.*	*n.s.*	-.174***	*n.s.*
H8b: Education → Intention	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
H8c: Children → Intention	*n.s.*	.103*	*n.s.*	.109**	*n.s.*
H8d: Income → Intention	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

Note. n.s. = not significant; *s.i.* = no direct effect but significant indirect effects.
**p<0.05; **p<0.01; ***p<0.001.*

For *H1,* our findings did not support the suggestion that respondents with previous experience with flood events would be more willing to implement GI practices (Table 3 and Figure 5). Alternately, for *H2,* respondents who had previously experienced flood events were more likely to perceive a higher probability and severity of upcoming flood events in all five GI models. Threat experience appraisal had a positive and significant effect on both threat probability and threat severity. The effects (β) ranged from .182 to .230 with R^2 values ranging from .033 to .053. While we did not observe a direct effect of experience on intention across models, small indirect effects were found significant in green roofs (β=.033, *t*=2.384), rain gardens (β=.027, *t*=2.070), and permeable pavement models (β=.026, *t*=2.287) through threat probability (Table 4).

Table 4. Indirect effects on intention

Path	β				
	Green roof	**Rain barrel**	**Rain garden**	**Permeable pavement**	**Tree planting and protection**
Experience → Threat probability → Intention	.033*	*n.s.*	.027*	.026*	*n.s.*
Reliance 1, 2→ Threat probability → Intention	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

Note. n.s. = not significant.
**p<0.05; **p<0.01; ***p<0.001.*

Hypothesis *H3* was partly confirmed by our results (Table 3). Respondents who reported higher perceived flood probability were more likely to report being more willing to implement green roofs (β=.144, *t*=2.886), rain gardens (β=.112, *t*=2.296), permeable pavement (β=.136, *t*=2.880), and tree planting and protection (β=.104, *t*=2.213). It was, however, not significant for the adoption of rain barrels. Also, perceived threat severity failed to substantially affect the intention to implement any GI practices.

3.4.2. Effects of reliance on public flood protection

Hypothesis *H4a* was supported in four out of the five GI models, for which we observed a negative effect of experience on satisfaction with current public flood protection measures (Table 3). These findings suggest that for respondents who had previously experienced a flood event, their satisfaction with the current public flood protection measures declined. Trust in public management of flood risk, however, was not significantly influenced by experience across models (H4b). Furthermore, satisfaction with current public flood protection measures also had a significant negative effect on threat probability and threat severity in four out of five GI models (*H5a* and *H5b*). In other words, when respondents' satisfaction with current public flood protection measures increased, their perceived flood probability and severity decreased.

For hypothesis *H6,* suggesting that satisfaction with current public flood protection measures and trust in public management of flood risk would be negatively related to the intention to implement private GI practices was not fully supported by our models (Table 3). Contrary to our hypothesis, satisfaction with current public flood protection measures and trust in public management of flood risk positively influenced the intention to implement some GI practices. These results suggest that homeowners are more willing to implement tree protection and planting (β=.094, *t*=2.011) when they have greater satisfaction with current public flood protection measures. Alternately, they are more willing to install green roofs (β=.152, *t*=3.049), rain gardens (β=.165, *t*=3.358), and permeable pavement (β=.158, *t*=3.345) when they have greater trust in the public management of flood risk.

3.4.3. Effects of coping appraisal

Our hypothesis *H7,* suggesting that homeowners with a high coping appraisal in terms of effectiveness, cost, and co-benefits, would express greater willingness to implement GI practices, was partly supported across the five GI models (Table 3). As such, respondents were more likely to adopt the five GI practices to protect their household from future flooding if they considered them effective and inexpensive. Across models, both perceived effectiveness or perceived cost were the strongest predictors of intention to adopt GI practices with effects ranging from small (.097) to moderate (.301). Perceived co-benefits had a positive effect on the intention to adopt rain barrels (β=.151, *t*=3.229), permeable pavement (β=.110, *t*=2.314), and tree protection and planting (β=.164, *t*=3.490).

3.4.4. Effects of socio-demographic characteristics

Of socio-demographic variables, only age and children were found to have some influence on the intention to implement GI, although, their effects differed by practice. Specifically, being younger corresponded with an increased intention to implement green roofs (β=-.246, *t*=-4.933) and permeable pavement (β=-.174, *t*=-3.630). Alternately, having more children corresponded with an increased intention to implement rain barrels (β=.103, *t*=2.242) and permeable pavement (β=.109, *t*=2.272). The variables of income and education, however, were not significant in any of our models.

3.4.5. Clustering effects

Two-level path models were used to examine the clustering effects of city and flood planning region on homeowners' intention to implement GI practices. At level 2 - city, the ICC estimates for 5 GI models showed that less than 2.6% of the variance in intention to implement GI practices was attributable to city differences. And at level 2 – flood planning region, the ICC estimates for 5 GI models showed that less than 2.1% of the variance in intention to implement GI practices was attributable to flood planning region differences. Similarly, the values of ICCs across other perceptual variables were extremely low.

4. DISCUSSION AND POLICY IMPLICATIONS

4.1. Discussion of main findings

The primary purpose of this research was to explore Texas Gulf Coast homeowners' perceptions of GI and their motivation to adopt five GI practices including green roofs, rain barrels, rain gardens, permeable pavement, and tree planting and protection. Our findings revealed that GI practices still have not been well recognized by Texas Gulf Coast homeowners which, in turn, impacted their willingness to implement them on their properties. Despite the government efforts to promote GI, homeowners in our sample were not interested in the adoption of GI practices given the lack of information related to GI, incentives, and guidance.

In the context of our five private GI practices and similar to what has previously been reported Derkzen et al. (2017), respondents tended to favor aesthetically attractive and more effective practices (e.g., gardens). However, rain barrels and tree protection and planting were the most frequently reported practices respondents intended to adopt. Consistent with past work (Carlet, 2015; Derkzen et al., 2017), this difference could be attributed to respondents' familiarity with the practice, ease of installation, and expense. This speaks to an urgent need for improving public knowledge of GI and other nature-based solutions. Since the concept of "green infrastructure" is relatively new and nebulous for the public, planners, and other practitioners, resistance to change has always been a barrier to the adoption of such new technologies (Abhold et al., 2011; Funkhouser, 2007; Hammitt, 2010). Much remains to be done to better inform the public of the benefits of GI.

This research's contribution to GI policy and practice can also be seen in the findings related to several tenants of PMT. Our PMT path analysis revealed that coping appraisal, the self-perceived ability to conduct GI practices to cope with flood, had the strongest influence on respondents' intention to undertake the installation of GI. Homeowners who expected the GI practices to effectively reduce flood damage and be low-cost in terms of effort, time, and money also expressed a stronger intent to implement those practices. This finding was consistent with a related study (Baptiste et al., 2015) reporting that efficacy and cost are key factors affecting individual willingness to implement GI. Although co-benefit was not found to be a significant predictor of intention to implement green roofs and rain gardens, its effects on the intention to implement rain barrels, permeable pavement, and tree protection and planting were influential. This finding further illustrates the importance of how an awareness of GI (effectiveness, cost, and benefit) shapes individuals' assessment of their ability to conduct GI practices which further drives their protection motivation. Consequently, outreach and communication strategies for GI should be accompanied by additional information on different practices of GI, their effectiveness in dealing with flood events, their co-benefits, as well as guidance to install and maintain. Given that the perceived cost of GI was found to be an indicator and barrier to implementation, financial incentives in the form of stormwater fee discounts, grants, rebates, and installation financing could further ameliorate homeowners' reluctance (Kloss, 2008).

Third, our path analysis revealed that threat appraisal had a minor effect on the intention compared to coping appraisal. In general, those homeowners expressing a higher threat probability were more willing to implement GI practices like green roofs, rain gardens, permeable pavement, and tree planting and protection which aligns with previous studies (Baptiste et al., 2015; Yu et al., 2019). There was, however, no significant effect found for threat severity. Although coping appraisal (perceived GI effectiveness, cost, and co-benefit) was reported to have the strongest influence on intent to implement GI, it does not necessarily mean that threat appraisal is not as important as the coping appraisal. Past work has shown that without an appraisal of threat, there is no incentive to take action to protect from the threat (Kuhlicke et al., 2020). Moreover, our descriptive analyses revealed that respondents' ratings of threat probability and severity were relatively low. Given the frequency and severity of past flood events along the Texas Gulf Coast region (Gori et al., 2022), this level of threat appraisal can be a concern for flood risk management. These data reveal that underestimation or disregard for the risk posed by storm events in the Texas Gulf Coast can hinder the adoption of GI and possibly place residents and their communities at greater risk (Bonaiuto et al., 2016). The result may have practical relevance in flood risk communication strategies. For example, informing potential flood-vulnerable residents of the probability of flood events and the urgency to act while informing them about the effectiveness, cost, and multiple benefits of GI practices, would likely influence their protection motivation in the desired direction.

In terms of experience (threat experience appraisal), we observed that experience was a significant driver of threat appraisal which is consistent with previous work examining the influence of previous experience on threat appraisal and risk perception toward natural disaster events (Burger & Palmer, 1992; Burningham et al., 2008; Grothmann & Reusswig, 2006; Kellens et al., 2011; Knuth et al., 2014; Peacock et al., 2005). There was, however, no significant effect of experience on the willingness to implement GI. This result differs from some previous GI work (Baptiste, 2014; Baptiste et al., 2015; Coleman et al., 2018; Yu et al., 2019), but is in line with Ando and Freitas (2011) who found that the adoption of rain barrels was not associated with the experience of local flooding. While we did not observe a direct effect of experience on intention across our models, there were indirect effects in the models of green roofs, rain gardens, and permeable pavement that are congruent with this earlier work.

Contrary to our hypothesis and previous PMT studies (Bötzen & van den Bergh, 2012; Grothmann & Reusswig, 2006; Terpstra, 2011), satisfaction with current public flood protection measures and trust in public management of flood risk were found to positively impact intention to adopt some GI. The results suggested that respondents were more willing to implement tree protection and planting when they have greater satisfaction with current public flood protection measures. Additionally, respondents were more willing to install green roofs, rain gardens, and permeable pavement when they had greater trust in the public management of flood risk. This result aligns with several previous studies (Poussin et al., 2015; Reynaud et al., 2013; Richert et al., 2017). These positive associations may be an artifact of some communities' efforts to support GI development. As part of the Green Infrastructure for Texas program (GIFT), several of the cities from which our respondents were drawn have been encouraging homeowners to utilize GI and other nature-based solutions to mitigate the adverse impacts of floods. While these cities' messaging related to threat probability and severity remains a challenge, respondents trust their city's management of flood risks appears to be yielding other benefits such as a greater willingness to implement GI.

Among socio-demographic variables, we found that age was the strongest indicator of intention and number of children was the second, although their effects differed per practice. For the green roof models, the influence of age on the intention was even stronger than other perceptual variables. The income and education variables were not significant in any of our models. These mixed results have been reported in other studies with different types of mitigation measures (Baptiste, 2014; Botzen et al., 2009; Byrne & Wolch, 2009; Kreibich et al., 2005; Poussin et al., 2015). It appears a combination of different types of GI practice along with varied social, cultural, and political contexts shape how demographic measures influence attitudes toward GI. For example, green roofs along the Texas Gulf Coast (and the US, more generally) are very rare. While it appears, younger generations are more accepting, traditional materials (e.g., composite shingles, metal) remain the culturally accepted norm for roof construction. We suspect different forms of GI will have greater acceptance among different demographic cohorts across the globe. Last, despite the fact that homeowners in our sample reside in different Texas coastal cities and various flood planning regions across the state, we did not observe any significant differences in the intention to implement GI practices among homeowners within these different geographical regions.

4.2. Limitations

It should be noted that there are several limitations concerning this investigation. First, this study only investigated the *protection motivation* (intention or willingness to take action), not the *protection response* (actual behavior and action that has been taken to prevent damage). As mentioned by Venkataramanan et al. (2020), intention only reflects individual stated preferences which are a less reliable indicator of the actual behavior. While measuring actual behavior can be challenging for study design, it remains critically necessary.

Second, this study surveyed residents of cities along the Texas Gulf Coast which might share similar geographic characteristics but represent different demographics in terms of city scale, income, education levels, etc. For example, when considering our sampled Texas cities, there was a notable disparity in median household income, ranging from $42,555 to $211,202 with an average of $69,853 in 2021. Among them, a city with a wealthier and higher level of education might have more interest in local environmental issues (Berke, 1996; Burby et al., 1997). Past work has also shown that residents of wealthier cities tend to have a greater political voice, along with more financial, human, and technical resources to cope with environmental issues (Brody et al., 2006; Tang & Brody, 2009). As such, residents in those cities may receive and consume more information related to their flood risk and mitigation opportunities. Third, this study did not measure the respondents' location and proximity to the potential risks (e.g., floodplain or coastline) which has also been shown to influence the levels of risk perception (Brody et al., 2008; Kellens et al., 2011; Miceli et al., 2008; Wachinger et al., 2013). Consequently, future analyses should consider the inclusion of city-specific and proximity variables to achieve a more holistic understanding of the relationship with the intention to implement GI practices.

Finally, this study employed single-item measures for all constructs in the GI model, instead of multiple item measures. While the use of single-item measures poses various psychometric advantages, such as reducing the chance of common method variance, shortening survey length, reducing research costs, and reducing consuming time for respondents (Hoeppner et al., 2011), it is often considered as a psychometrically suspect in terms of validity, sensitivity, and reliability. For example, in our study, the single item of response cost might not be able to fully capture the variations within the construct because response cost represents the monetary and non-monetary costs of each GI practice. Therefore, it would be beneficial to assess and compare the use of single-item versus multiple-item measures in future GI studies utilizing the PMT.

5. CONCLUSIONS

In this investigation, we drew upon the PMT theoretical framework to understand residents' evaluation and attitudes toward GI. Our findings provide insight into the utility of PMT for further understanding residents' perceptions of GI. Furthermore, our findings contribute to the Gulf Coast's attempts to minimize threats to its coastal communities in times of climate change and increasing hazards. The results provide insight for city policymakers and planners in the Gulf Coast region concerning the promotion and development of GI that can provide the impetus for implementation and contribute to the mitigation of future flood hazards and build resilience. Finally, the study could be replicated in many other coastal cities vulnerable to the threat of natural hazards.

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Appendix A. Five green infrastructure practices

Green infrastructure practices	**Photo used in survey**
Green roofs Private vegetation on a house roof, consisting of a layered construction on which plants such as mosses, succulents, and herbs grow (Derkzen et al., 2017)	
Rain barrels Rain barrels are devices belong to the rainwater harvesting system which helps to reduce stormwater pollution by slowing runoff and collecting rainfall for later uses (EPA)	
Rain gardens Rain gardens are shallow, vegetated basins that collect and absorb runoff from rooftop, sidewalks, and streets (EPA)	
Permeable pavement/ surface Permeable surfaces are often made of permeable materials (e.g., pervious concrete, porous asphalt) to infiltrate, treat and/ or store rainwater where it falls (EPA)	
Tree protection and planting Trees can absorb stormwater, provide cooling shades, and improve the overall urban environment. Homeowners and community groups can participate in protection, maintaining and planting trees (EPA)	

Appendix B. Descriptive statistics for the socio-demographic variables (n=608)

Demographic characteristics	**Summary**
Gender: % female	67.93
Length of residency:	12.27
Dwelling type: %	
Single-family home, not attached to another house	84.70
Single-family home, attached to another house	5.59
Apartment in an apartment building	1.64
Mobile home or trailer	7.07
Other	0.99
Age: %	
18-25	31.74
26-45	34.05
46-65	23.03
66 and older	11.18
Education: %	
High school	24.34
Some college	27.14
Associate's degree	15.13
Bachelor's degree	21.55
Masters, Doctoral, or Professional Degree	11.84
Race: %	
Hispanic, Latino, or Spanish origin	23.19
Black or African American	12.01
White	50.00
Asian	6.58
Other	8.22
Number of children: median (range)	0 (0-10)
Income: %	
Less than $25,000	22.70
$25,000 - $49,999	15.79
$50,000 - $74,999	13.65
$75,000 - $99,999	21.88
$100,000 - $149,999	12.66
$150,000 - $199,999	5.10
$200,000 - $249,999	3.78
$250,000 - $299,999	1.15
$300,000 or more	3.29

Appendix C. Means and standard deviation of some manifest variables (n=608)

Demographic characteristics	**Mean (SD)**
Previous experience	.605 (.489)
Household preparedness	2.668(1.070)
Threat probability	2.961(1.136)
Threat severity	4.166(2.593)
Reliance 1 – flood protection	2.987(1.129)
Reliance 2 – flood risk management	2.457(1.127)

Appendix D. Items, item wording, means and standard deviation.

Variable	Label	M (*SD*)
Threat experience appraisal	In the last 10 years, have you ever experienced a flood event?	.605 (.489)
Threat probability	How likely do you think that your household will experience a flood event in the near future?	2.961(1.136)
Threat severity	Indicate the extent to which you believe your household will be impacted by severe flood events in the next 10 years	4.166(2.593)
Reliance 1 - Flood protection	To what extent do you agree with the following statement: "I am satisfied with the current public flood protection measures (e.g., coastal, river dikes, levees) in my city."	2.987(1.129)
Reliance 2 - Flood risk management	To what extent do you agree with the following statement: "Current public management of flood risk (e.g., flood warning, disaster relief) in my city makes me feel safe from future flooding."	2.457(1.127)
Response effectiveness	Please rate the effectiveness of each green infrastructure measure below for mitigating the negative impacts of floods.	Varied by GI practices
Response cost	Please rate the cost of each green infrastructure measure below in terms of effort, time, and money.	Varied by GI practices
Response co-benefit	Which social/ environmental/ economic benefits do you think you can obtain from applying the green infrastructure practices below?	Varied by GI practices
Intention	Please indicate the likelihood that you would implement each green infrastructure measure below to protect your household and community from future flooding?	Varied by GI practices
Age	What is your age?	
Children	How many children under the age of 18 live in your household?	
Education	What is your highest level of education?	
Income	Which of the following best describes your household income before taxes?	

Appendix E. Pearson correlation matrix for green infrastructure models

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Green roof (N=323)													
1. Experience	1												
2. Threat 1	.230***	1											
3. Threat 2	.218***	.615***	1										
4. Reliance 1	-.146**	-.141*	-.127*	1									
5. Reliance 2	-.062	-.023	-.017	.486***	1								
6. Effectiveness	.030	.088	.118*	.084	.100	1							
7. Cost	.032	.012	.031	-.004	-.010	.056	1						
8. Co-benefit	.072	.072	.133*	.003	.074	.183**	-.115*	1					
9. Age	-.248***	-.079	-.001	.075	.044	-.060	-.089	-.135*	1				
10. Education	-.020	.027	.018	.053	.050	.010	-.027	-.011	.157**	1			
11. Children	.113*	.084	.109	-.050	-.006	.054	-.032	.062	-.169**	.088	1		
12. Income	.062	.046	.009	.056	-.013	-.018	-.023	-.044	-.018	.448***	.171**	1	
13. Intention	.086	.176**	.143**	.010	.151**	.227***	.263**	.099	-.278***	-.036	.087	-.004	1
Rain barrel (N=408)													
1. Experience	1												
2. Threat 1	.239***	1											
3. Threat 2	.227***	.645***	1										
4. Reliance 1	-.162**	-.181***	-.176***	1									
5. Reliance 2	-.055	-.101*	-.127*	.566***	1								
6. Effectiveness	-.008	.096	.072	.173***	.198***	1							
7. Cost	.035	-.052	-.149*	-.026	-.023	-.092	1						
8. Co-benefit	.019	.048	.114*	.004	.089	.181***	-.109*	1					
9. Age	-.196***	-.035	.012	.044	.019	-.102*	.147**	-.145**	1				
10. Education	-.053	.014	.004	.050	.028	-.037	.058	-.017	.179***	1			
11. Children	.094	.073	.089	-.046	-.037	.064	-.006	.018	-.215***	.053	1		
12. Income	.051	.040	-.001	.041	.026	-.054	.149**	-.026	-.029	.413***	.151**	1	
13. Intention	.064	.099*	.032	.029	.116*	.321***	.094	.192***	-.084	-.076	.123*	.038	1
Rain garden (N=373)													

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Experience	1												
2. Threat 1	.248***	1											
3. Threat 2	.220***	.626***	1										
4. Reliance 1	-.171**	-.198***	-.206***	1									
5. Reliance 2	-.081	-.103*	-.090	.536***	1								
6. Effectiveness	.016	.060	.048	.045	.157**	1							
7. Cost	.004	-.094	-.054	.001	-.011	.027	1						
8. Co-benefit	.055	.020	.077	-.006	.076	.149**	-.042	1					
9. Age	-.250***	-.062	.015	.045	.028	-.100	.018	-.062	1				
10. Education	-.040	.016	.022	.024	.010	.049	-.013	.047	.197***	1			
11. Children	.106*	.071	.076	-.042	-.050	.067	-.023	.029	-.197***	.082	1		
12. Income	.058	.037	-.019	.058	.011	-.008	.000	-.043	-.020	.398***	.156**	1	
13. Intention	.058	.095	.061	.017	.186***	.263***	.137**	.119*	-.112*	-.012	.099	.012	1
Permeable pavement (N=379)													
1. Experience	1												
2. Threat 1	.203***	1											
3. Threat 2	.197***	.627***	1										
4. Reliance 1	-.107*	-.145*	-.142**	1									
5. Reliance 2	-.058	-.086	-.077	.557***	1								
6. Effectiveness	.040	.007	.022	.034	.149**	1							
7. Cost	.002	.015	.035	-.149**	-.144**	-.125*	1						
8. Co-benefit	.079	.089	.099	.073	.145**	.141**	-.005	1					
9. Age	-.245***	-.066	.018	.076	.050	.000	-.250***	-.163**	1				
10. Education	-.026	.052	.049	.040	.012	.026	-.044	.043	.180**	1			
11. Children	.129*	.049	.082	-.013	-.036	.001	0.099	.052	-.186***	.077	1		
12. Income	.061	.011	-.005	.066	.007	.029	-.049	-.053	.006	.435***	.146**	1	
13. Intention	.032	.151**	.101*	.023	.130*	.107*	.239***	.189***	-.264***	-.025	.168**	.004	1
Tree planting and protection (N=401)													
1. Experience	1												

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
2. Threat 1	.215***	1											
3. Threat 2	.203***	.623***	1										
4. Reliance 1	-.129**	-.182***	-.185***	1									
5. Reliance 2	-.061	-.120*	-.127*	.556***	1								
6. Effectiveness	.007	.083	.037	.060	.129**	1							
7. Cost	.032	-.112*	-.113*	.038	.038	-.028	1						
8. Co-benefit	.041	.026	.021	-.043	.090	.198***	-.036	1					
9. Age	-.233***	-.066	.053	.027	.008	.070	-.038	-.019	1				
10. Education	-.040	.011	.024	.069	.038	.057	-.005	-.005	.190***	1			
11. Children	.117*	.072	.104*	-.038	-.041	.003	.002	.000	-.221***	.055	1		
12. Income	.050	.052	.014	.061	.052	-.014	.022	-.054	-.018	.390***	.153**	1	
13. Intention	.052	.096	.054	.090	.129**	.305***	.123*	.209***	.034	.045	.036	.035	1

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$.